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# Seasonal changes and distribution of seagrass along the coasts and some Islands in Sattahip District, Thailand

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***ABSTRACT***
A study of the variety and distribution of seagrass was conducted in 14 surveying areas during part of of year from March 2007 to February 2008 along the coasts and some islands in Sattahip district and adjacent areas including Bang Sare and Ban Chang district, Chonburi province. This study was performed by considering 3 major different seasons representing the season of before S/W monsoon, during S/W monsoon and after N/E monsoon, by surveying and collecting information in March 2007, July 2007 and February 2008, respectively. The results revealed that a total of 7 species in 4 genera 2 families of seagrass had been found from the intertidal zone to 16.7 meters in depth in which *Halophila decipiens* Ostenfeld (Hd) was the deepest habitat seagrass species. The variety, distribution and percentage coverage of seagrass had been changed by seasonal variation especially after the S/W monsoon period presenting the largest size of seagrass, high density and wide spread of seagrass.

**KEYWORDS: distribution, seagrass, Sattahip, Chonburi**

## INTRODUCTION

Seagrass beds are one of the most important ecological parts of marine resources because of habitat, nursery ground and nutrition utility of marine animals especially dugongs and sea turtles. All seagrass species could be used as a nutritional resource for the dugong (Adulyanukosol, 2006). In January 2007, dugong calfs appeared unexpectedly at Ao Sattahip in the restricted area under the responsibility of Royal Thai Navy. Consequently, the dugong conservation Co-operative Programme was initiated in Sattahip area to continuously protect the dugong surviving in the Thai-water boundary. However, there is a little information of relationship between seasonal changes and seagrass beds. For this reason, this study was focused on the variety and distribution of seagrass beds resulting from the influence of seasonal changes in order to find the most appropriate nutritional resource, nursery ground and habitat areas for the dugong and consider the optimal environmental factors to promote the dugong conservation in Thailand.

## MATERIALS AND METHODS

The study area was located along the coasts and some islands in Sattahip district and adjacent areas including Bang Sare and Ban Chang district, Chon Buri province, and covers approximately 113.35 kilometers divided into 14 sites (Fig.1). In Thailand, the climate is under monsoonal influence and can be classified in three periods of 1) without monsoon season (March-May), 2) a rainy season predominated by the S/W Monsoon (June-October) and 3) a dry season predominated by N/E Monsoon (November-February). Therefore, the studies conducted in March 2007, July 2007 and February 2008 represent the before monsoon, rainy and dry seasons, respectively. There is a diurnal tide with a range of tidal level between 0.5 to 3.2 m on chart datum in which the lowest tidal level in day time appears in the rainy season and highest tidal level appears in dry season. The spot check survey method was applied from English *et al.* (1994). The spot marking was located on 200 m. in line transects and 500 m. between line transects. Seagrass identification, the percentage cover by visual estimation, water depth and other environmental factors were conducted and recorded immediately at the study sites.

## RESULTS

### Variety of seagrass species

There were 7 species in 4 genera 2 families of seagrass such as *Halophila decipiens* Ostenfeld **(Hd)**, *Halophila ovalis* (R.Browm) Hooker f. **(Ho)**, *Halophila minor* (Zollinger) den Hartog **(Hm)**, *Halodule uninervis* (Forsskål) Ascherson **(Hu)**, *Halodule pinifolia* (Miki) den Hartog **(Hp)**, *Enhalus acoroides* (L.f.) Royle **(Ea)** and *Cymodocea serrulata (R.Brown)* Ascherson and Magnus **(Cs)** found in the study sites.

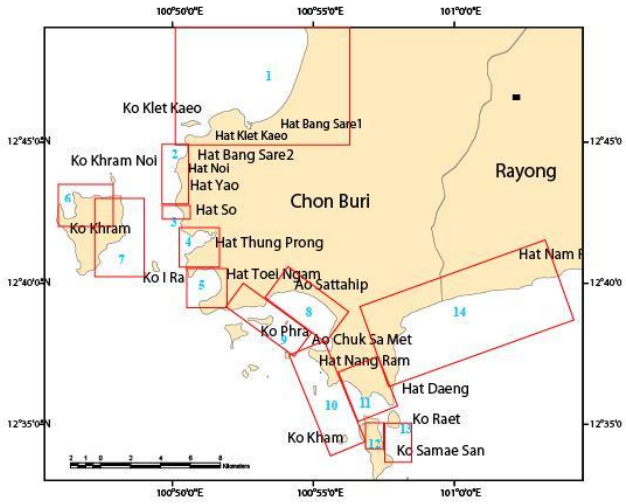


**Fig. 1** Map of study areas in Sattahip, Chonburi province and adjacent areas

**Seagrass beds distribution**

Table 1 presents species distribution of seagrass in each seasonal period and revealed that there were 12 of 14 sites except 1st, 3rd site having seagrasses. Figs. 2 to 4 show surveying points and seagrass distribution in March 2007, July 2007 and February 2008, respectively. Furthermore, Table 1 provides information of seagrass beds in each study site and shows that the 8th site had the most rich seagrass varieties, classified into 6 species, and the most common species was Hd. When considering the seagrass distribution in March 2007, the study sites had a high percentage cover of seagrass and Ho and Hd were dominant species in almost areas as shown in Fig.2 and Table 2. However Hu was dominant around the nearshore at 5th and 8th and Ea was dominate just at the 12th study site. The seagrass distribution in July 2007 showed that there was a scarcity of seagrass beds distribution. However, the 5th, 8th, 9th, 12th and the 14th study sites consisted of a high percentage cover of seagrass. The Hu was the dominant species as presented in Fig.3. In February 2008, the 5th - 6th, 8th - 10th study sites presented the largest size of seagrass, high density and wide spread of seagrass and found that Hd was dominant in deep water which was located at 5th and 10th sites while Ho dominated in shallow water located at 6th and 8th sites as mentioned in Fig.4 and Table 2.


**Fig. 2** Surveying points and seagrass distribution in March 2007

**Table 1** Species distribution of seagrass in each period

| part | duration | Seagrass species | | | | | | | No.of species |
|---|---|---|---|---|---|---|---|---|---|
| | | Hd | Ho | Hm | Hu | Hp | Ea | Cs | |
| 1. Hat Bang Sare - Hat Klet Kaeo | - | | | | | | | | - |
| 2. Hat Bang Sare2 - Hat Noi - Hat Yao | Mar. 2007 | • | • | | | | | | 2 |
| | Jul. 2007 | | | | | | | | |
| | Feb. 2008 | • | | | | | | | |
| 3. Hat So | - | | | | | | | | - |
| 4. Ao Thung Prong | Mar. 2007 | | • | • | • | | | | 4 |
| | Jul. 2007 | • | | | • | | | | |
| | Feb. 2008 | • | | | • | | | | |
| 5. Ao Toei Ngam | Mar. 2007 | • | | | • | | | | 3 |
| | Jul. 2007 | | | | • | | | | |
| | Feb. 2008 | • | • | | • | | | | |
| 6. Ko Khram (N) | Mar. 2007 | | • | • | | | | | 2 |
| | Jul. 2007 | | • | • | | | | | |
| | Feb. 2008 | | • | • | | | | | |
| 7. Ko Khram (SE) | Mar. 2007 | • | • | • | • | | | | 4 |
| | Jul. 2007 | | | | • | | | | |
| | Feb. 2008 | • | | | • | | | | |
| 8. Ao Sattahip - Ao Chuk Sa Met | Mar. 2007 | | • | • | • | • | | | 6 |
| | Jul. 2007 | • | • | • | • | • | | • | |
| | Feb. 2008 | • | • | • | • | • | | | |
| 9. Ko Phra | Mar. 2007 | | • | | | • | | | 3 |
| | Jul. 2007 | • | • | | | | | | |
| | Feb. 2008 | • | • | | | | | | |
| 10. Hat Nang Ram - Ko Kham | Mar. 2007 | • | | | | | | | 3 |
| | Jul. 2007 | • | • | | | | | | |
| | Feb. 2008 | • | • | | • | | | | |
| 11. Ko Samae San (N) | Mar. 2007 | • | | | | | | | 2 |
| | Jul. 2007 | • | • | | | | | | |
| | Feb. 2008 | • | • | | | | | | |
| 12. Ko Samae San (E) | Mar. 2007 | | | | | | • | | 2 |
| | Jul. 2007 | | | • | | | • | | |
| | Feb. 2008 | | | • | | | • | | |
| 13. Ko Raet (S) | Mar. 2007 | • | | | | | | | 1 |
| | Jul. 2007 | • | | | | | | | |
| | Feb. 2008 | • | | | | | | | |
| 14. Hat Daeng - Hat Nam Rin | Mar. 2007 | | | | | | | | 1 |
| | Jul. 2007 | | | | • | | | | |
| | Feb. 2008 | | | | • | | | | |

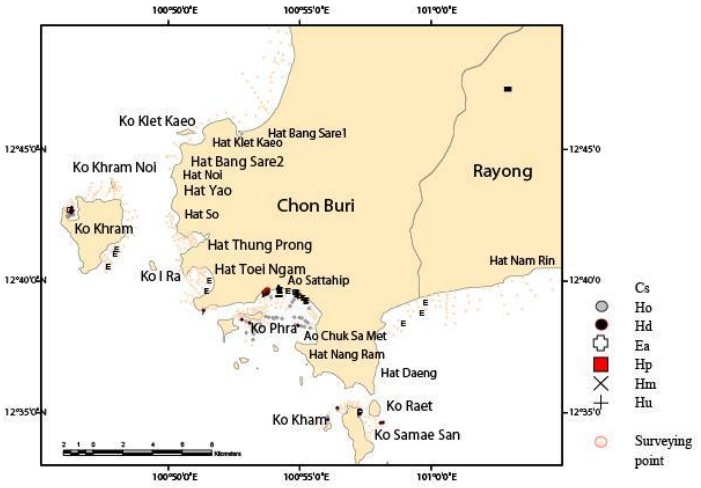


**Fig. 3** Surveying points and seagrass distribution in July 2007


**Fig. 4** Surveying points and seagrass distribution in February 2008

**Depth range**

The seagrass distribution occupied from 0-16.7 m. in depth of sea level. Seagrass beds had been discovered 16.7 m. in depth at the 6th study site in February 2008 or after the monsoon season. The distribution of seagrass beds in deep water were also found at the 7th, 10th, 11th and 13th study sites. In addition, some seagrass beds were found both in shallow and deep water such as site 5th and 8th. At the 5th study site, Hu and a few number of Ho were founded at near shore area in shallow water whereas Hd was found in deeper water and far from shore area. At the 8th study site, Hu, Hp and Hm were always found in shallow water while Ho and Hd were found in deeper water as shown in Table 2.

The depth ranges of seagrass habitat in each species are shown in Table 3 in which Hm, Ho, Hu and Hp could be found in a wide depth range. The Hd was always found in deep water while Ea and Cs were always found in shallow water.

**Environmental factors**

The environmental factors of each study area are presented in Table 4. The deepest seagrass species was found in the area having a high transparency and lower temperature after the monsoon season in February 2008. The lowest transparency of sea water could be found in July 2007. Moreover, the salinity, temperature and pH were not different when comparing with the environmental factors in March 2007.

**DISCUSSION**

From our results, we found that at the 5th study site, Ho appeared at near shore in shallow water instead of Hm. We also discovered Ho at the 6th site. In addition, Ho, Hm and Hu were surprisingly appeared at the 7th site. At the 8th site Hd, Hu and Cs were surprisingly found. Unfortunately, at the 9th site, Hm was not able to be found in this study. At the 10th site, even Hp disappeared but Ho was discovered. At site 12, Cs was not seen in this study and differs from the study of Chaksuin (1998) and Kaewsuralikhit, *et al*. (2003). However, at the channel between Ko Khram and Ko Khram Noi, Hd had been found as mentioned in the study of Lewmanomont,*et al.*(2003). However, revelation of Ho and Hm in different times might be caused by Ho morphological variation as described in *Halophila* species diversity study of Uchimura *et al*. (2008).

It can be noted that Ho, Hm and Hd were found in various areas presenting a wide distribution. In addition, Hd and Ho appeared in almost all areas of study both in horizontal and vertical direction after the monsoon season in February (Fig.5). The reason for the appearance could be that Hd is able to grow in narrow light intensity because of stenohaline character (http://www.sms.si.edu/irlspec/ Halop_decipi.htm), therefore, Hd appeared outside the intertidal zone, whereas Ho can be endure a hard intensity of light and wide range of light resulting in a survival at a wide interval of depths (Table 3). Therefore, if sea water has low turbidity, Hd could be found in deep water. During the monsoonal period, Hd, Ho and Hm disappeared. However, there was a high density of Hu in semi-enclosed topography (Fig.3, Tab.2). After the monsoon, they were widely distributed, germinated from seeds and grew which is the cause of location changing of seagrass beds. Finally, we can conclude that during the S/E monsoon period seagrass had less distribution. After the monsoon, the distribution of seagrass beds during the monsoonal season will appear in wide spread

areas and a high variety of seagrass species resulting from the influence of seasonal changes. This information provides the seasonal carrying capacities of seagrass beds in Sattahip which is one area where dugongs are found beyond Rayong and Trat province area (Hines *et al*., 2003). By the way uncertainly dugongs were found along eastern gulf of Thailand. Therefore the information can be employed to prohibit fishing gear that cause threat to dugong especially at seagrass beds, including water quality control to ensure the continuity of the dugong in Thailand

**Table 2** Site description of seagrass beds

| site | period | Area (km2) | Depth | | | Average of seagrass cover (%) |
|---|---|---|---|---|---|---|
| | | | min | max | average | |
| 1. Hat Bang Sare - Hat Klet Kaeo | - | - | - | - | - | - |
| 2. Hat Bang Sare2 - Hat Noi - Hat Yao | Mar. 2007 | 1.099 | 2.4 | 8.6 | 6.3 | 25 |
| | Jul. 2007 | - | - | - | - | - |
| | Feb. 2008 | 0.111 | 3.9 | 7.2 | 6.7 | 10 |
| 3. Hat So | - | - | - | - | - | - |
| 4. Ao Thung Prong | Mar. 2007 | 0.106 | 0.4 | 3.6 | 3.0 | 84 |
| | Jul. 2007 | - | - | - | - | - |
| | Feb. 2008 | 0.073 | 1.7 | 7.0 | 5.5 | 10 |
| 5. Ao Toei Ngam | Mar. 2007 | 0.232 | 0.5 | 3.0 | 2.7 | 78 |
| | Jul. 2007 | 0.068 | 0.4 | 4.3 | 3.6 | 45 |
| | Feb. 2008 | 0.775 | 0.2 | 8.8 | 3.1/ 7.5 | 34/ 13 (shallow/deep) |
| 6. Ko Khram (N) | Mar. 2007 | 0.614 | 2.9 | 10.5 | 5.1 | 53 |
| | Jul. 2007 | 0.200 | 0 | 8.9 | 6.4 | 27 |
| | Feb. 2008 | 0.309 | 1.1 | 16.7 | 7.0 | 35 |
| 7. Ko Khram (SE) | Mar. 2007 | 0.466 | 7.3 | 14.5 | 11.9 | 31 |
| | Jul. 2007 | 0.151 | 7.2 | 11.7 | 10.6 | 1 |
| | Feb. 2008 | 0.269 | 1.4 | 11.7 | 8.4 | 20 |
| 8. Ao Sattahip - Ao Chuk Sa Met | Mar. 2007 | 0.923 | 0.4 | 7.4 | 3.8/ 6.6 | 28/ 15 (shallow/deep) |
| | Jul. 2007 | 1.214 | 0 | 8.9 | 3.1/ 7 | 78/ 36 (shallow/deep) |
| | Feb. 2008 | 2.587 | 0 | 8.7 | 3.6/ 7 | 68/ 18 (shallow/deep) |
| 9. Ko Phra | Mar. 2007 | 0.048 | 1.9 | 5.9 | 5.2 | 13 |
| | Jul. 2007 | 0.876 | 4.1 | 11.0 | 8.3 | 16 |
| | Feb. 2008 | 2.566 | 1.9 | 10.9 | 7.5 | 11 |
| 10. Hat Nang Ram - Ko Kham | Mar. 2007 | 0.237 | 10.5 | 13.8 | 13.0 | 20 |
| | Jul. 2007 | 0.056 | 5.3 | 8.5 | 8.2 | 6 |
| | Feb. 2008 | 1.143 | 6.9 | 14.5 | 11.1 | 23 |
| 11. Ko Samae San (N) | Mar. 2007 | 0.060 | 6.1 | 10.7 | 10.0 | 26 |
| | Jul. 2007 | 0.033 | 6.1 | 10.2 | 9.4 | 4 |
| | Feb. 2008 | 0.215 | 5.2 | 11.5 | 9.6 | 27 |
| 12. Ko Samae San (E) | Mar. 2007 | 0.062 | 0.5 | 2.7 | 2.7 | 51 |
| | Jul. 2007 | 0.045 | 0.2 | 4.9 | 2.8 | 40 |
| | Feb. 2008 | 0.065 | 1.2 | 3.5 | 3.5 | 55 |
| 13. Ko Raet (S) | Mar. 2007 | 0.005 | 9.0 | 11.2 | 11.2 | 5 |
| | Jul. 2007 | 0.033 | 10.3 | 13.5 | 13.2 | 25 |
| | Feb. 2008 | 0.057 | 8.1 | 11.4 | 10.7 | 33 |
| 14. Hat Daeng - Hat Nam Rin | Mar. 2007 | - | - | - | - | - |
| | Jul. 2007 | 0.077 | 1.5 | 5.5 | 3.6 | 45 |
| | Feb. 2008 | 0.199 | 2.5 | 6.4 | 6.6 | 8 |

**Table 3** Depth ranges of seagrass species.

| species | Depth (m) |
|---|---|
| *Halophila minor* (Hm) | 0 – 12.0 |
| *Halophila ovalis* (Ho) | 0 – 12.0 |
| *Halodule uninervis* (Hu) | 0 – 11.8 |
| *Halodule pinifolia* (Hp) | 0 – 7.1 |
| *Halophila decipiens* (Hd) | 2.6 – 16.7 |
| *Enhalus acoroides* (Ea) | 0.2 – 4.9 |
| *Cymodocea serrulata* (Cs) | 1.1 – 3.8 |

**Table 4** Environmental factors of study areas

| | Depth (m) | Transparency (m) | Salinity (‰) | Temp. ($^0$C) | pH |
|---|---|---|---|---|---|
| March 2007 | 0 – 14.5 | 7.0 | 29 - 31 | 29 - 32 | 7.9 – 8.4 |
| July 2007 | 0 – 13.5 | 6.3 | 28 - 31 | 29 - 32 | 7.0 – 8.3 |
| Febuary 2008 | 0 – 16.7 | 8.0 | 29 - 31 | 25 - 30 | 7.9 – 8.4 |

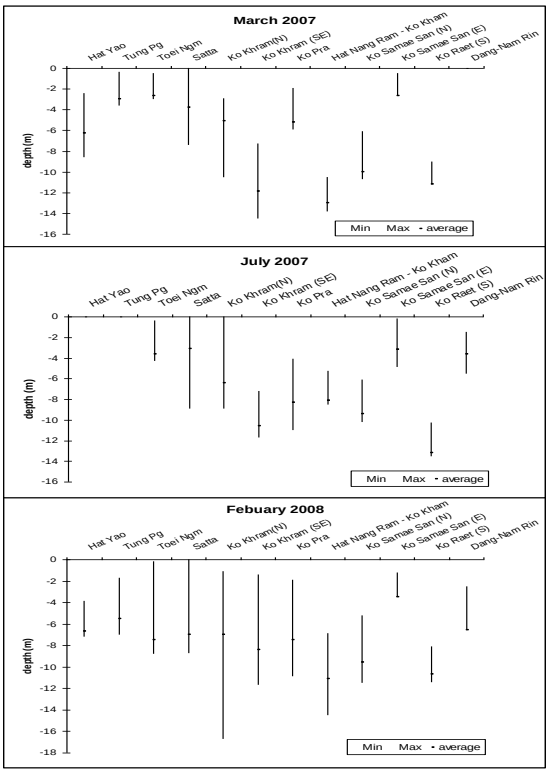


**Fig. 5** Depth ranges of seagrass beds


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